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U.S. ATOMIC ENERGY COMMISSION

Division of Biology and Medicine

CONFERENCE ON GENETICS
Argonne National Laboratory
November 19-20, 1954

SUMMARY

A Conference on Genetics was held at Argonne National Laboratory on November 19-20, 1954, under the sponsorship of the Division of Biology and Medicine. The purposes of the conference were to review the present status of research in all the areas of genetics and to furnish guides for the development of the AEC research program in genetics.

The participants were E. C. Stakman, who served as Chairman, Curt Stern, W. L. Russell, J. R. Singleton, W. H. Giles, E. L. Powers, W. S. Stone, G. W. Beadle, H. H. Plough, J. V. Neel, Theodosius Dobzhansky, Bruce Wallace, H. B. Glass, and Sewall Wright. The Division of Biology and Medicine was represented by John C. Bugher and E. L. Green. A complete stenotypist recording of the discussions is available for reference.

In his opening remarks, Dr. Stakman pointed out the necessity for orienting research programs toward basic studies, yet having in mind the solutions of immediate problems. Dr. Bugher drew the attention of the conference to the new responsibility which has come to rest on geneticists as a consequence of man's modification of his environment and to the clear cut need for replacing opinions with conclusions in the formulation of national policy.

The ensuing discussions were arranged in four parts corresponding with genetic studies at the (1) gene level, (2) chromosome level, (3) cell, tissue, and organism level, and (4) population level.

(1) MUTATION STUDIES

The following questions were discussed:

1. What is known about rates of spontaneous mutation? Spontaneous mutations occur but estimates of rates are complicated by variations between organisms, variations from locus to locus within organisms, variations in developmental stage, and variations in technique. For lethal mutations in *Drosophila* the rate is 10^{-5} per locus.

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2. Are mutations reversible? Yes, including X-ray induced mutations in Neurospora. But some do not reverse.
3. What radiation dosage is needed to double the rate of mutation? 30 to 80 r in the mouse, but this is not a very useful figure since it depends upon the spontaneous mutation rate.
4. What is the effect of storage of sperm, as in artificial insemination in livestock, on the mutation rate and on the accumulation of mutations?
5. Are specific loci characterized by different mutation rates? Yes.
6. Is the relationship between radiation dosage and gene mutation rate linear? Yes, over dosages studied; but very low dosage under specific environmental conditions should be studied further.
7. What is rate of induced mutation? About 25×10^{-8} per r per locus in mouse spermatogonia.

(2) CYTOGENETICS

1. What is relationship between radiation dosage and frequency of various kinds of chromosomal aberrations? Some types of changes (translocations) show a geometrical increase with radiation dose; others (deletions) show a linear increase.
2. Is there any difference between results when radiation is acute, chronic, or fractionated? Yes, there is a fractionation effect, fractionated doses produce fewer changes than the same total dose given at once.
3. Are agents known which modify the effect of radiation on chromosomes? Yes, ~~decrease~~ ^{increase} in oxygen increases number of chromosome aberrations recovered.
4. To what extent are chromosomal changes involved in the development of radiation damage in mammals?
5. How do gene mutation rates correlate with chromosomal aberration rates under varying amounts of irradiation?

(3) BIOCHEMICAL, PHYSIOLOGICAL, AND DEVELOPMENTAL GENETICS

1. Recent advances in the analysis of the structure of DNA may clarify the chemical nature of genes and the manner of genetic control of biosynthesis. Also the new model may explain gene duplication, crossing over, mutation, and other genetic phenomena.
2. The phenomenon of transduction needs further experimental attention.
3. What accounts for the large differences between organisms in radiation sensitivity?
4. What is known about different mechanisms which enable an organism, once one biochemical pathway is blocked, to overcome this defect and develop a nonmutant phenotype?
5. Studies in the area of developmental genetics are timely.

(4) POPULATION GENETICS

1. What are the theoretical responses of populations to radiation? An equilibrium will be reached between mutation pressure and selection pressure, the exact point of equilibrium and the length of time required depending upon the pressures, and the kinds of genes involved.
2. What is the response of experimental populations to radiation? Information is available on Drosophila populations, but on no others.
3. What is the effect of deleterious mutant genes on the viability and other properties of heterozygotes?
4. How much irradiation is necessary to wipe out a population? In Drosophila 14,000 r per generation was sufficient. If man is 100 times more reactive than Drosophila, 140 r per generation may be sufficient to exterminate a human population.
5. How does the breeding structure of a population influence the long range effects of radiation?
6. Can radiation be used, in conjunction with a suitable breeding and selection program to produce new desirable strains of plants and animals?
7. What data are necessary to shed light on the evaluation of genetic damage in mammals for first generation data?

SUMMARY

Many suggestions for specific research projects in genetics emerged from the discussions. Some of these suggestions bear upon AEC's interest in genetic research. In addition to studies already in progress or likely to be developed as an outgrowth of current thinking by geneticists, three principal questions of direct interest to AEC grew out of the conference on genetics.

First, what are the spontaneous and the radiation induced mutation rates in man? To estimate the induced mutation rate directly will be impossible. To estimate it indirectly from animal experiments is necessary, but difficult. The best suggestion to date is to design experiments to yield data on the relationship between gene mutation rate and radiation dosage and between chromosomal aberration rate and radiation dosage in a large number of species of plants and animals, to design other experiments to define the relationship between chromosome aberration rate and dosage in human cells in tissue culture, then to use all the data to predict the human mutation rate.

Second, what will be the effect of radiation on the genetic constitution of populations of mankind? This question must also be approached by designing experiments which in one way or another, will shed light on the genetic parameters needed to describe human population.

Third, in what ways may radiation, in conjunction with specific breeding programs, be used to develop varieties of plants and animals which man regards as useful?

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